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The Effect of Exercise on Emotion Regulation

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Abstract

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There is a substantial body of research on the effect that exercise has on emotion and on self-regulation. However, there has not been a great deal of research on the effect that exercise has on emotion regulation, which is crucial for normal functioning in society. Thus, this thesis investigated the relationship between physical activity and emotion regulation. Forty-five Union College students participated in the study. Individuals first filled out various questionnaires relating to physical activity and emotion regulation and then were asked to bike in the lab for a 20-minute period. Participants were randomly assigned to either the low-intensity or high-intensity condition and upon completion of the exercise manipulation, individuals engaged in an emotion regulation task. It was hypothesized that individuals in the high-intensity condition would be better at utilizing the three main emotion regulation strategies of attentional deployment, cognitive reappraisal, and expression suppression in response to the negative images in the emotion regulation task. The hypotheses were not supported as there were no significant differences between the high-intensity and low-intensity-conditions on the emotion regulation task. Limitations of the experimental design may have contributed to this lack of findings. Thus, although the main hypotheses were not supported, the effect that exercise has on emotion regulation is an important question in today's society and should be continued to be studied in the future.

Keywords: exercise, physical activity, emotion regulation

The Effect of Exercise on Emotion Regulation

Emotion regulation is fundamental to normal functioning in society (Gross & Munoz, 1995). Emotions have an impact on internal processes such as memory and decision-making as well as external events such as social interactions (Gross, 1995). Because of this, it could be useful to improve these skills in order to make the individual more functional on a personal level and in society. In line with this idea, it has been suggested that physical activity could impact an individual's ability to regulate their emotions (e.g., Oaten & Cheng, 2006). So that a specific target can be focused on when trying to improve emotion regulation, it is important to know what stage of emotion regulation is most impacted by physical activity. Thus, this thesis was designed to examine the specific stages of emotion regulation that might be affected by physical activity. To examine this question, it is important to first understand what exactly emotion regulation is.

Emotion Regulation

Although emotion is tied into every aspect of our lives and is a major component of what makes people who they are, exactly what emotion entails and encompasses can be difficult to pinpoint. According to Gross and Munoz (1995), emotion is a biologically-based reaction that coordinates adaptive responding to important opportunities and challenges. Emotion encompasses various aspects of responding, including the subjective experience, expressive behavior, and physiological responding. People differ in how they manage their emotions at each of these three levels. Although emotions can support adaptations such as goal pursuit, stress management, and cognitive performance, (Thompson, 1994), emotions can also undermine effective functioning and get in the way of these actions. To avoid disruption and a potential inability to function, it is necessary for people to regulate their emotions.

Emotion regulation consists of both extrinsic and intrinsic processes that can involve both enhancing as well as inhibiting emotions, depending on the goal of the situation (Thompson, 1994). Extrinsic emotion regulation involves outside influences on emotion. Parents scolding or punishing children to not be upset over something minimal is an example of extrinsic emotion regulation. Intrinsic emotion regulation, on the other hand, refers to self-management of emotions (Thompson, 1994). For example, one may want to enhance his or her emotions when trying to be sympathetic to a friend. Although the friend's distress over a situation may not directly concern the individual, appearing to have similar emotions may work to comfort the friend and enhancing this emotion would therefore be beneficial to the relationship. Inhibiting emotions are desirable when, for example, a person avoids crying in a public setting after hearing bad news. Because crying in public generally goes against American social norms, inhibiting this emotion would lead to avoidance of questioning and disapproval by others. In line with Thompson's (1994) definition, both of these examples are forms of intrinsic regulation. Although intrinsic and extrinsic emotion regulation differ in regards to who is directing the behavior, both forms can be used to inhibit or enhance a wide variety of emotional expressions.

At the same time, emotion regulation is a complex phenomenon, as it consists of monitoring, evaluating, and modifying emotional reactions to one's goals (Thompson, 1994). It is not only the actual emotion expressed by the individual that can be regulated, but the emotional experience of intensity, speed of onset, and length of persistence can also be altered. Overall, emotions can be regulated in a plethora of ways due to the many different steps in the process that can be reformed.

Steps in Emotion Regulation

Gross (2001) outlines the five steps in the emotion generative process, four of these steps are antecedent-focused and one is response-focused. This categorization differs from that of Koole (2009), who classifies emotion regulation strategies based on their targets and functions. Targets in emotion regulation include attention, knowledge, and bodily responses. Although different from the conceptualization of Gross (2001), the targets of attention and knowledge are likely to function during antecedent-focused strategies, whereas the target of bodily responses is more likely to function during response-focused strategies (Koole, 2009). Compared to response-focused emotion regulation which includes all strategies that aim to alter an emotion after it is actually elicited, antecedent-focused emotion regulation includes all strategies that aim to alter an emotion before it is actually elicited (Gross, 2001). In line with this classification, there are several points at which antecedent-focused regulation can occur.

The first is situation selection, which occurs when the individual chooses the situation in which he or she wants to be (Gross, 2001). If someone is looking to experience a certain emotion, he or she can choose a certain situation. For example, a person may elect to watch a comedy on television to elicit positive emotions. On the other hand, if an entire situation is avoided, so too can the emotions that could potentially accompany it. For example, a child may stay in his or her room to avoid being near and thus feeling badly about the fight occurring between their siblings. Whether it involves avoiding or entering in a situation, both are forms of antecedent-focused regulation because it involves modifications before the emotion is elicited.

The second and third strategies outlined by Gross (2001) seem to focus on attention, the neurological network that allows people to select certain information from a wide variety of sensory input (Koole, 2009). Situation modification, the second form of antecedent-focused emotion regulation, occurs in instances where an individual can change aspects of the situation

chosen, in order to be more or less emotionally aroused (Gross, 2001). For example, a person may decide to go out with friends, even though he or she has an exam the next day. To ensure he or she does not feel guilty about doing so, if a friend brings up studying, the individual could say he or she would prefer to not talk about it. Attentional deployment, the third form of antecedent-focused emotion regulation, occurs in instances where the individual chooses the aspects of the modified situation on which he or she wants to focus (Gross, 2001). Attentional deployment can be separated into distraction and concentration (Webb, Miles, & Sheeran, 2012). For example, if the friend continues to talk about a topic that the individual wants to avoid, the individual may distract himself or herself by pretending to listen but really just people watching. A person may also choose to use concentration and just focus on another aspect of the situation instead. Both situational selection and attentional deployment center on changing the focus of attention, which has the potential to drastically change the emotional response. In addition, both strategies are considered antecedent-focused because measures taken to alter the potential emotion before it is actually elicited.

The last type of antecedent-focused emotion regulation is cognitive reappraisal (Gross, 2001). Also called cognitive change, this strategy comes into play when a meaning is attached to the emotional situation that a person encounters. Cognitive reappraisal refers to how an individual appraises a situation that he or she is in to alter its emotional significance, by either changing how the individual thinks about it or by his or her ability to manage its demands (Webb et al., 2012). This strategy also maps onto the knowledge target described by Koole (2009), in that knowledge of whether or not an emotion is hindering or enhancing a goal is crucial to how the emotion will be felt and expressed. For example, when the friend continues to talk about the test, the individual can remind himself or herself that it is only a small percentage of his or her

grade and that it will not be the end of the world if performance is poor. Thus, cognitive reappraisal involves altering the way an individual thinks about a certain situation in order to modify its emotional impact (John & Gross, 2004). It is considered antecedent-focused regulation because it influences whether or not an emotion is triggered during an encounter with an emotionally significant event.

Both Gross (2001) and Koole (2009) posit that the final aspect of emotion regulation occurs after the emotion is experienced. According to Koole (2009), this is the final target and it includes bodily responses, including facial expression, posture, motor movements, and physiological responses. According to Gross (2001), this is the final step of the five-step process, which is labeled response modulation. Unlike the conceptualization of Koole (2009), response modulation is not solely focused on bodily response but rather includes influencing physiological, experiential, or behavioral responding and can include just one or all of these aspects (Webb et al., 2012). One specific type of response modulation is expressive suppression, a response-focused strategy that involves reducing emotion-expressive behavior once the individual is already in an emotional state (John & Gross, 2004). For example, after not studying for an exam, a student may want to hide his or her embarrassment or dissatisfaction with his or her grade when the test is returned. Thus, the student may suppress the expression of these emotions in the situation. The key to such response-focused emotion regulation strategies is that they are employed after an emotion is already under-way, and thus such strategies focus on how an emotional response is modified once it has already been triggered. In sum, emotion regulation strategies can be distinguished by their focus on emotional experience versus emotional expression. Although such strategies can be employed in different ways and at different times,

one also needs to consider how emotion regulation increases the effectiveness with which a person navigates his or her environment.

Purpose of Emotion Regulation

Individuals use emotion regulation to retain the helpful aspects of emotions and limit the damaging features (Thompson, 1994). For example in a friendly soccer game, one player might commit a dirty and unnecessary foul on another player, as that player is about to score a goal. Instead of starting a fight with the opponent or screaming at the referee, the individual may inhibit such emotions and direct that energy at playing even better. This is not only more socially acceptable but would also be beneficial to avoid getting a yellow or red card and being kicked out of the game.

Emotional regulation serves many important functions including satisfying hedonic needs, supporting goals, and facilitating the "global personality system" (Koole, 2009). Because negative emotional states are costly, emotional regulation aims to promote pleasure and prevent pain, thereby making us more effective and efficient people. In terms of supporting goals, emotional regulation is crucial. For example, if someone is trying to lose weight but makes a bad decision and binges, he or she will feel guilty and will be less likely to go against their goals in the future. Finally, emotion regulation works to facilitate the global personality system. Because personality is made up of many interacting processes, regulation can promote flexibility in personality functioning as well as promote coherence and stability of a person as a whole (Koole, 2009). Because emotions have both helpful and damaging features, emotion regulation works to manage these aspects for the benefit of the person experiencing the emotion as well as those around them.

Given the importance of emotion regulation, it is necessary to investigate factors that may influence its employment and success. Although research suggests that many factors such as social interactions (e.g., Thompson, 1994), sleep (e.g., Ready, Marquez, & Akerstedt, 2009), and age (e.g., Ready et al., 2009) impact emotion regulation, this study was designed to examine how emotion regulation processes might be impacted by physical activity. Much of the research that suggests that physical activity and emotion regulation may be related is indirect. More specifically, this research evidence has looked at two components of emotion regulation: emotional experience and self-regulation.

Physical Activity and Emotions

The first relevant area that a substantial amount of research has addressed is the effect of physical activity on emotional experience. One of the ways this is researched is in a clinical setting, as physical activity has recently become more popular as a treatment. Hays and Sime (2014) looked at how physical activity has been used as a therapy and examined its effects over various studies. In a review of 40 studies, exercise was found to reduce levels of anxiety. They even go so far as to say that the biochemical mechanisms that occur during exercise are equal or possibly more effective in treating anxiety than psychotropic medications (Hays & Sime, 2014). Many other studies were examined that as a whole, showed the positive effect of exercise on not only anxiety but general mental health (Hays & Sime, 2014). Due to this positive impact on mental health, it is plausible that it may also have positive benefits for emotion regulation, a behavior related to personal well-being and individual functioning.

Various ideas exist as to why exercise is a benefit to mental health. According to the thermogenic hypothesis, physical exercise is beneficial to mental health because exercise is shown to increase tolerance for both heat and cold (Hays & Sime, 2014). The physiological

process of modulating core temperature has previously been proven to influence emotional stability. The second hypothesis that is often discussed is the neurotransmitter hypothesis. This says that exercise raises the levels of various neurotransmitters such as dopamine and serotonin and impacts chemicals that are responsible for the construction of new connections and neurons (Hays & Sime, 2014). It is also explained in the neurotransmitter hypothesis that exercise plays a role in decreasing sympathetic and increasing parasympathetic activity, which is associated with a simultaneous improvement in emotional stability (Hays & Sime, 2014). Finally, the psychological hypothesis says that physical activity is involved in the regulation of social distance (Hays & Sime, 2014). When people are depressed or anxious, for example, they tend to decrease contact with other people. Many forms of physical activity such as playing sports involve social interaction. Therefore, social isolation is reduced, which often makes symptoms of mental health disorders less prominent. Whereas this might be true, on the other hand, exercise can provide the rare opportunity for reflection and self-nurturance in today's busy world, which is also crucial to mental health (Hays & Sime, 2014). Regardless of which hypothesis is correct, these studies provide initial, indirect evidence for a possible link between exercise and emotion regulation, which means that it is crucial to further investigate this phenomenon.

Physical Activity and Self-Regulation

Because emotion regulation is a subcategory of self-regulation, it is important to look at physical activity as it relates to self-regulation as a whole as well. Becker, McClelland, Loprinzi, and Trost (2014) looked at the effect of physical activity on pre-kindergarten children. They investigated whether active play at recess was associated with self-regulation and academic achievement. They hypothesized that higher activity levels would be positively associated with higher levels of self-regulation and that self-regulation would be positively correlated with

academic achievement. Active play was assessed using a movement-detecting device and children performed a self-regulation task that involved following directions. The Head-Toes-Knees-Shoulders task was used and children are instructed to touch one of these body parts but do the opposite of whatever the experimenter said. For example, if instructed to touch the head, children are supposed to touch the toes instead. Both hypotheses were supported as higher levels of active play predicted better self-regulation, and better self-regulation predicted higher academic achievement. Due to the fact that emotion regulation is a form of self-regulation, this study indirectly suggests that higher activity levels in pre-kindergarten children may lead to better emotion regulation abilities.

In another study, changes in self-regulatory abilities were examined in response to physical activity (Oaten and Cheng, 2006). Self-regulatory performance was assessed at baseline and again after a two-month long physical exercise program (Oaten and Cheng, 2006). During the exercise phase, participants reported an increase in emotional control as well as a decrease in impulse spending, watching television instead of studying, procrastination, and other behaviors reflecting a lack of self-regulation. After the physical exercise program, participants also did better on visual tracking during distraction and thought suppression tasks, which the authors hypothesized to be the result of reduced vulnerability to the effects of slef-regulatory depletion. Overall, this study suggests that regular physical activity might be one route to improve regulatory performance.

Additional evidence comes from work that has looked into the association between emotion regulation and compulsive exercise attitudes in adolescents. Goodwin, Haycraft and Meyer (2012) examined both functional and dysfunctional emotion regulation. Adolescents' self-reported levels of compulsive exercise, emotion regulation, and disordered eating attitudes. It

was found that compulsive exercise was significantly related to emotion regulation, as many adolescents rely on exercise to manage their emotions. Among boys, compulsive exercise was associated with internal functional, internal dysfunctional, and external functional emotion regulation strategies. In girls, internal functional and internal dysfunctional emotion regulation strategies predicted compulsive exercise. Overall, Goodwin and colleagues (2012) provided correlational evidence of the positive relationship between exercise behavior and emotion regulation, suggesting that the link between exercise and emotion regulation may only be beneficial up to a point. While it was not clear from these studies whether adolescents were using antecedent-focused techniques or response-focused techniques to regulate their emotions, it is important to consider so that someone can pinpoint exactly when emotion regulation is happening and proceed accordingly with subsequent research and interventions.

Emotion Regulation Stages and Physical Activity

Antecedent-focused. In the Oaten and Cheng (2006) study discussed above, it is possible that participants were less affected by self-regulatory depletion due to an increased attentional ability post-exercise. If this is the case, it also suggests a likely increase in attentional deployment during self-regulation. Other studies have also suggested an increased effectiveness of attentional deployment in emotion regulation due to exercise. Booth, Tomporowski, Boyle, Ness, Joinson, Leary, and Reilly (2013) looked at the association between executive attention and physical activity in adolescents. Physical activity was measured using a movement detection device and attention was measured by three recognition tasks. Participants also had to take part in reaction time tests. It was found that higher amounts of moderate to vigorous physical activity were associated with better performance on attention tasks in both 11- and 13-year olds. If

physical activity increases general attentional abilities, this study indirectly suggests that it could also affect the attentional deployment stage in emotion regulation.

Budde, Voelcker-Rehage, Pietrabyk-Kenziorra, Ribeiro, and Tidow (2008) also supported the hypothesis that attentional deployment techniques could be more effective after exercise. They hypothesized that bilateral coordinative exercise would have a stronger positive effect on attention compared to a non-specific physical activity lesson. This is because coordinative exercise is known to involve an activation of the cerebellum, which influences systems such as attention and working memory (Budde et al., 2008). Coordinative exercises were chosen from training forms for soccer and exercises from the Munich fitness test. In the non-specific condition, teachers instructed students to exercise at moderate intensity without any special requests. Each group performed the assigned exercise task for ten minutes and afterwards performed an attention task. It was found that the correlation between pre- and post-test performance was higher for the control than the experimental group, suggesting that individuals in the experimental group reduced their errors after participating in the intervention program. Because the type of exercise stressed in the coordinative exercise group is believed to have more motor complexity, it therefore comes with more brain activation and therefore a better information processing ability (Budde et al., 2008). Results support the idea that even short, intense bouts of exercise will have a positive effect on one's ability to pay attention, and in turn may have a positive effect on emotional regulation in the attentional deployment stage.

Given the vast array of cognitive benefits that physical activity provides, it is plausible that physical activity may also impact the area of cognitive change. Thermanson, Hillman, and Curtin (2006) looked at the influence of physical activity on task switching in both younger and older adults. In the homogenous task, participants viewed a series of digits on a computer screen

and had to indicate whether each digit was greater or less than five or if the digit was even or odd. In the heterogeneous task, individuals had to indicate both. Physical activity was assessed using self-report measures. Regardless of age, it was found that as physical activity increased, response time decreased, with no sacrifice of task performance (Thermanson et al., 2006). It was also found that as physical activity increased, post-error response slowing was more often observed. In other words, when more physically active participants made a mistake, they took a longer time to respond to the next stimulus, as they are implementing more top-down attentional control to increase performance (Thermanson et al., 2006). This suggests that regardless of age, physical activity is associated with greater executive control, as more physically active adults have better cognitive control than those that are less physically active. Although it is indirect, greater cognitive control is likely to be related to more effective antecedent-focused emotion regulation in the cognitive reappraisal stage.

There are other pieces of evidence for an increase in cognitive reappraisal abilities following physical activity. A meta-analysis of literature on the effect of fitness training on cognition, well-being, and brain function found that the biggest effects of physical activity were in the areas of executive control tasks such as planning, scheduling, working memory, multi-tasking, and being able to focus when distractions are present (Kramer & Erikson, 2007). In an experimental study, Hogan, Mata, and Carstensen (2013) looked at affective experience immediately following a period of moderate exercise. In the study, participants were randomly assigned to either the exercise condition, involving 15 minutes of moderate intensity cycling, or the control condition, in which they completed ratings of neutral images. All participants completed affect assessments before and after the trial, indicating how they felt at the time. Working memory was also assessed using a stimuli-matching test. Results suggest that exercise

was associated with increased levels of high-arousal positive affect and decreased levels of low-arousal positive affect. The study also found that regardless of age, exercise lead to faster reaction times on working memory tests, indicating increased cognitive abilities. Due to this evidence for the cognitive benefits of physical activity for both younger and older adults, exercise may also have similarly positive effects on one's ability to use cognitive reappraisal in the emotion regulation process. In terms of emotion regulation, cognitive reappraisal is the last step in antecedent-focused emotion regulation. After cognitive reappraisal occurs, the only way left to regulate an emotion is through response-focused emotion regulation techniques.

Response-focused. Indirect research evidence also seems to suggest that physical activity may be related expression suppression, the final step in the emotion regulation process. Specifically, physical activity has been related to the expression of negative emotions. Mata, Hogan, Joormann, Waugh, and Gotlib (2013) looked at the effect of acute exercise of patients who have recovered from major depressive disorder, which is characterized by high levels of negative affect and low levels of positive affect. It was hypothesized that compared to participants who did not exercise, those who did partake in the exercise would report a smaller increase in negative affect and a smaller decrease in positive affect when exposed to film clips intended to induce a negative mood. Participants biked at a pace they found comfortable for 15 minutes and watched a two-minute sad film afterwards. The hypothesis was partially supported as those who exercised reported a smaller increase in negative affect following the film clip compared to those who did not; however, there was no difference seen for positive affect. Thus, these participants did experience negative affect, but those who exercised showed a better ability to regulate these emotional responses. These results suggest that physical activity could play a part in expression suppression, the final step in the emotion regulation process.

Current Study

The aim of this thesis was to investigate if physical activity had an impact on specific stages of emotion regulation. As discussed earlier, there are five steps in the emotion regulation process, and it was hypothesized that physical activity would have an impact on three major levels. First, given its impact on attentional processes, physical activity was hypothesized to impact attentional deployment abilities. This is an antecedent-focused level because modifications are made before an emotion is actually elicited. Secondly, based on evidence that physical activity improves cognitive abilities, physical activity was hypothesized to impact cognitive reappraisal, another antecedent-focused strategy. Finally, it was hypothesized that physical activity would increase an individual's ability to suppress their emotions, which is the final step in the emotion regulation process and is characterized as a response-focused technique because it is employed after the emotion is already elicited.

Method

Participants

Fifty-eight Union College undergraduates participated in this study after being provided informed consent. Participants were recruited through an online system and upon completion of the study were compensated with either partial course credit or $8 for their participation. However, fourteen students were excluded from analyses. Three questions throughout the experiment were designed to assess random responding by requiring that participants provide a particular answer; five participants answered two or more of these incorrectly. Three participants were unable to correctly report the heart rate to which they were assigned for the cycling task and did not complete the task correctly. Seven participants inaccurately answered three or more questions about the directions for the emotion regulation task after receiving verbal and on-

screen instructions as well as a written tutorial; two of these individuals also failed one or more of the checks described above, and thus, an additional five participants total were excluded.

Forty-five students were included in the analyses. Although both men and women were included, a computer programming error caused the gender of each participant not to be recorded. Students were between the ages of 18 and 22 (M = 20.11, SD = 1.42). In terms of ethnicity, 6.7 % identified as Hispanic or Latino, whereas 93.3% of the sample identified as not Hispanic or Latino. The sample included five different racial groups, with the overwhelming majority being white (White = 82.2%, Asian = 6.7%, Black = 2.2%, Other = 6.7%, More than one = 2.2%).

Procedure

Participants completed this study individually. Upon arrival, participants were told that the experiment dealt with how physical activity affects one's ability to regulate emotions. The participants were directed into an individual room to complete a variety of questionnaires asking about emotion regulation, self-regulation, and physical activity.

After the self-report measures were completed on the computer, participants came back into the main area and engaged in the exercise task. Once this 20-minute exercise manipulation period was completed, participants were directed back into the individual room to fill out a brief manipulation check. Then the experimenter explained the directions for the emotion regulation task and gave a detailed explanation of the five specific emotion regulation strategies that the participant would use in the task. The experimenter also explained what valence and arousal meant and explained how the participant was going to rate each factor after seeing the images. Participants filled out short-response as well as multiple-choice questions to ensure that they understood precisely what each strategy consisted of (see Appendix B). Once this was complete,

individuals took part in the emotion regulation task, which was followed by a manipulation check questionnaire (see Appendix C). Finally, participants completed a demographic questionnaire. They were then debriefed and handed their compensation.

Materials

Cycling task. A Schwinn IC Elite stationary bike was used in the lab. The seat was adjusted for the comfort of the participant. An Omron HR-210 Strap Free Heart Rate Monitor was adjusted to the participant's wrist and reset at the start of the exercise period. While engaging in exercise, a short, neutral movie showing nature scenes was shown on a computer screen. Scenes shown in the movie were retrieved from YouTube. The movie also included cues to check the heart rate monitor every two minutes to ensure the participant was biking at the assigned difficulty (as described below).

IAPS images. Sixty images were chosen from the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008). Both negative and neutral images were chosen. These images significantly differed in IAPS ratings of valence (M = 2.55, SD= 0.36 for negative, M= 4.85, SD= 0.54 for neutral), t (58) = 17.77, p < 0.01, d = 5.74, and in IAPS ratings of arousal (M = 5.38, SD= 0.50 for negative, M= 4.57, SD= 0.50 for neutral), t (58) = -5.01, p < 0.01, d = -1.62. Images were presented on a Lenovo monitor.

Measures and Tasks

Emotion regulation scale (John & Gross, 2003). Participants rated ten statements about the way in which the individual controls his or her emotions on a *1(strongly disagree)* to *7 (strongly agree)* scale. The first six statements related to reappraisal abilities, and the final four statements related to suppression abilities. Both the reappraisal subscale ($\alpha = 0.83$) and the suppression subscale ($\alpha = 0.77$) were found to have good internal consistency in this study.

Cognitive emotion regulation questionnaire (Garnefski, Kraaij, & Spinhoven, 2002). This questionnaire includes 18 questions, asking about the way in which the individual responds when confronted with negative or unpleasant events. Regarding each statement, participants rated each question on a scale of *1 (almost never)* to *5 (almost always)*. There were nine subscales that each consisted of two questions. Internal consistency for most of the subscales was found to be acceptable to good: acceptance ($\alpha = 0.81$), rumination ($\alpha = 0.73$), positive reappraisal ($\alpha = 0.76$), self-blame ($\alpha = 0.72$), positive refocusing ($\alpha = 0.72$), catastrophizing ($\alpha = 0.85$), refocus on planning ($\alpha = 0.60$), putting into perspective ($\alpha = 0.51$), and other-blame ($\alpha = 0.85$).

Brief self-control scale (Tangney, Baumeister & Boone, 2004). This scale had participants rate the extent to which each of the 13 statements described the type of person that he or she is. It encompassed various aspects of self-control, including control over thoughts, emotional control, impulse control, and performance regulation. The participant would rate each statement on a scale of *1 (not at all like me)* to *7 (very much like me)*. This scale was found to have acceptable internal consistency in this thesis, $\alpha = 0.76$.

Exercise self-regulation (Rovniak, Anderson, Winett, & Stephens, 2002). The exercise self-regulation goals questionnaire is composed of 10 questions referring to how the individual sets exercise goals; the scale evidenced good internal consistency in this thesis, $\alpha = 0.88$. The exercise self-regulation plans questionnaire is composed of 10 questions referring to how the individual plans exercise activities; the scale evidenced acceptable internal consistency in this thesis, $\alpha = 0.72$. On both questionnaires, participants rated how much each statement described one's self on a *1 (does not describe)* to *5 (completely describes)* scale.

Stages of exercise change (Marcus, Selby, Niaura, & Rossi, 1992). This one-item measure asked participants to select one out of the five options that best represented his or her

current exercise behavior and intentions. The statements represented precontemplation, contemplation, preparation, action and maintenance. So participants would provide a more reliable rating, the scale defined "regular exercise," based on the U.S. Department of Health and Human Services (2008) Physical Activity Guidelines for American Adults (ages 18-64). This definition included three regular exercise options: (a) moderate-intensity physical activity (e.g., walking briskly, water aerobics, bicycling slower than 10 miles per hours, doubles tennis, ballroom dancing) for at least 150 minutes (two hours and 30 minutes) per week, (b) vigorous-intensity physical activity (e.g., jogging, running, singles tennis, aerobic dancing, bicycling 10 miles per hour or faster, jumping rope, hiking uphill) for at least 75 minutes (1 hour and 15 minutes) per week, or (c) an equivalent combination of moderate- and vigorous-intensity aerobic activity as listed above per week.

Stanford 7-day recall (Sallis, Haskell, Wood, Fortmann, Rogers, Balir & Paffenbarger 1985). The recall asked the participant to recall the total hours (to the nearest 0.5 hours) in the past 7 days that he or she participated in moderate exercise and in vigorous exercise. Each type was clearly defined in the scale and allowed for a free response option, as there are no choices to pick from. Reports of the time spent engaging in moderate- and vigorous-intensity physical activity over the past week were not significantly related to one another, $r = 0.07$, $p = 0.65$.

Perceived functional ability questions (George, Stone, & Burkett, 1997). This measure, which evidenced good internal consistency in this thesis, $\alpha = 0.92$, asked two questions that the participant responded to using one of seven options. The first question asked about which pace would be right for the participant (not too hard, not too easy) exercising continuously

on an indoor track for one mile. The second question asked how fast the participant could cover a distance of three-miles and not become overly fatigued.

Exercise task. To begin the exercise task, **t**he participant was handed a heart rate monitor, which was then secured to the wrist, and the experimenter showed him or her how to work it. Once the heart rate monitor was securely fastened, the participant mounted the bike. Half of the participants were randomly placed in the high-intensity exercise group and half were randomly placed in the low-intensity exercise group. Participants warmed up for three minutes, biked at the given heart rate for 15 minutes, and cooled down for two minutes. The high-intensity exercise group biked at a heart rate between 140-160 beats per minute (bpm), and the low-intensity group biked at a heart rate between 70-90 bpm. For both the warm up and cool down, groups biked between 60 and 80 bpm. While biking, participants watched a neutral nature video on the computer screen in front of them, which gave cues to check the heart rate monitor and reminded participants of the correct heart rates.

Exercise manipulation check. The check consisted of 23 items regarding feelings towards the biking task that the participant had just completed (Appendix A). The first three items were open-ended and asked about what heart rate the participant was supposed to maintain, what he or she personally tried to maintain, and what he or she actually maintained. The remaining 20 items asked the participant about various feelings he or she may have had when biking, including questions about exercise difficulty, heaviness of breathing, and sweating. The participant reported their answer on a 1-9 scale.

Brief mood introspection scale (Mayer & Gaschke, 1988). This scale consisted of 16 items that each had an emotion-adjective. On a *1 (definitely do not feel)* to *7 (definitely feel)* scale, the participant rated how much were currently experiencing each mood state. The arousal-

calm dimension evidenced poor internal consistency in this thesis, $\alpha = 0.51$, whereas the unpleasant-pleasant valence dimension evidenced acceptable internal consistency in this thesis, $\alpha = 0.77$.

Regulation task. Based on the methodology used by Thiruchselvam, Blechert, Sheppes, Rydstrom, and Gross (2011), the regulation task consisted of 60 pictures taken from the International Affective Picture System (IAPS) along with different emotion regulation prompts. Both neutral and negative images were employed, and the ratings of image valence and arousal were similar to other emotion regulation studies that have used the IAPS (e.g., Thiruchselvam et al., 2011).

Before each picture, a prompt was shown for 1 second that said one of the following: "DISTRACT", "REAPPRAISE", "SUPPRESS", "VIEW" or "WATCH". For both the "WATCH" and "VIEW" trials, subjects were instructed to simply attend to the image, allowing themselves to feel whatever they naturally would. Although "VIEW" and "WATCH" trials were essentially the same, "VIEW" was used for neutral images and "WATCH" was used for negative images. For "DISTRACT" trials, subjects were asked to feel neutral in response to the image by generating unrelated thoughts or images in their mind and focusing on those. For the "REAPPRAISE" trials, subjects were asked to think differently about the image and alter their construal in order to feel neutral when looking at the image. For the "SUPPRESS" trials, participants were asked to simply try to minimize their emotional reaction to the image, and have less intense of a response.

After receiving these instructions as well as examples from the experimenter, each participant completed an understanding check before the task began to ensure he or she knew exactly what to do. It consisted of five open-response questions that asked what to do when you

see each command. After entering their response, participants were again shown the directions for each prompt. The understanding check also include four, final multiple-choice questions that ensured understanding of valence and arousal (see Appendix B for full understanding check).

Each trial began with a white fixation cross, followed by one of the prompts, and then the image. Afterwards, they rated their level of valence as well as their level of arousal on a scale of 1-9 using the self-assessment manikin (SAM; Bradley & Lang, 1994) and moved on to the next picture. The SAM was used to self-report levels of valence and arousal and was created by Lang (1980). Each scale consisted of nine pictures of cartoon-like figures. For the valence scale, a high rating meant the image was pleasing to the participant, and a low rating meant that the image was not pleasing to the participant. For the arousal scale, a low rating meant that the participant was not very aroused, and a high rating meant that the participant was aroused, regardless of if the arousal was positive or negative in valence.

Emotion regulation task questionnaire. This questionnaire consisted of 27 items, which asked about feelings towards the emotion regulation task (Appendix C). The first 25 items were rated on a 7-point scale and asked about how the participant was feeling during the task. The final two items were open response and asked if the participant had any issues during the task and if the participant had an idea about the main hypotheses of the study.

Demographic questionnaire. The questionnaire consisted of 13 items, which were a variety of fill-in-the-blank and multiple-choice questions (Appendix D). It included questions about age, height, weight, ethnicity, and athletic involvement. It also asked how seriously the participant took the study.

Results

In the current study, it was hypothesized that physical activity should improve attentional deployment, cognitive reappraisal, and expression suppression abilities. It was clear that the exercise manipulation worked as it was supposed to (see Figure 1), as participants in the high-intensity condition responded with higher levels of shortness of breath (M = 3.00, SD = 2.07) than the low-intensity condition (M = 1.25, SD = 0.68), t (43) = -3.909, p < .001, d = -1.168. Those in the high-intensity condition also responded with higher levels of strenuousness during the task (M = 3.62, SD = 1.50) than those in the low-intensity condition (M = 1.33, SD = 0.70), t (43) = -6.686, p < .001, d = -1.749. Finally, high-intensity individuals also responded with higher levels of physical effort (M = 4.57, SD = 1.08) compared to those in the low-intensity condition (M = 1.96, SD = 1.197), t (43) = -7.656, p < .001, d = -2.00 as well as higher levels of physical challenge (M = 3.62, SD = 1.32) compared to those in the low-intensity condition (M = 1.67, SD = 0.702), t(43) = -6.298, p < .001, d = -1.81. In addition, as mentioned earlier, only those participants that correctly reported their condition-assigned bpm were included in these analyses.

The evidence from a repeated measures analysis of variance also suggests that the images worked as specified by the IAPS. Compared to negative images (M = 4.28, SD =1.45), neutral images (M = 3.22, SD = 1.15) elicited lower arousal valence ratings, F (1, 44) = 50.98, p < 0.001, partial η2 = 0.53. Compared to negative images (M = 3.50, SD = 0.79), neutral images (M = 5.07, SD = 0.64) also elicited more positive valence ratings, F (1, 44) = 110.52, p < 0.001, partial η2 = 0.79.

However, even though participants reported high confidence in being able to perform the emotion regulation strategies (i.e., M = 4.61, SD = 0.62, on 5-point Likert scale) and passed understanding check questions following the directions for the task, participants were unable to

actually modify their emotional reactions in response to the prompts. To compare trials for the three emotion regulation prompts (i.e., “distract,” “reappraise,” and “suppress”) and the "watch" trials in which participants were instructed to experience their natural emotion when seeing a negative image, a repeated measures analysis of variance using planned comparisons was conducted. Compared to the "watch" trials (M = 4.41, SD = 1.51), participants did not report significantly different levels of arousal on emotion regulation trials (M = 4.24, SD = 1.55) in which they were instructed to use distraction, reappraisal, or suppression to change their emotional experience of the images, F (1, 44) = 2.42, p = 0.13, partial η^2 = 0.05 (see Figure 2). In addition, compared to the "watch" trials (M = 3.40, SD = 0.73), participants did not report significantly different levels of valence on emotion regulation trials (M = 3.53, SD = 0.81) in which they were instructed to use distraction, reappraisal, or suppression to change their emotional experience of images, F (1, 44) = 1.92, p = 0.17, partial η^2 = 0.04 (see Figure 3). This suggests that participants failed to actually modify their emotional experiences in line with the task requirements.

As a test of the main hypotheses, a repeated measures analysis of variance with exercise condition as a between subjects factor was conducted to examine differences between the low- and high-intensity exercise conditions. For arousal, there was no difference between the three emotion regulation trial types based on exercise-intensity condition, F (2, 42) = 0.07, p = 0.93, partial η2 = 0.00. For arousal, there was no difference between the three emotion regulation trial types based on exercise-intensity condition, F (2, 42) = 0.18, p = 0.84, partial η2 = 0.01. This shows that regardless of the strategy employed, the high-intensity exercise group did not respond any differently to the images than the low-intensity exercise group.

To further examine how exercise might be related to performance on the emotion regulation task, self-report measures of physical activity were examined. Participants' report of their stage of exercise change did not predict arousal or valence on any of the three emotion regulation trial types, all $F(3, 41) < 1.30$, $p > 0.05$. As seen in Table 1, neither the amount of moderate physical activity nor the amount of vigorous physical activity over the past week was related to arousal or valence ratings across the three emotion regulation trial types. Cardiorespiratory endurance, as measured by the mean of the perceived functional ability items, also did not significantly relate to arousal or valence ratings across the three emotion regulation trial types (see Table 1). These results suggest that self-reported exercise did not significantly predict difference in emotion regulation, as measured by the experimental task.

Additional cross-sectional analyses were performed to determine if self-reported physical activity was related to trait levels of emotion regulation, exercise self-regulation, and self-control. Although participants' reports of the stage of exercise change were not related to any of the emotion regulation trait measures or trait self-control, it was related to exercise self-regulation in the form of goals, $F(3, 41) = 3.99$, $p = 0.01$, and plans, $F(3, 41) = 7.73$, $p < 0.001$. As seen in Table 2, a correlation analysis was conducted to test the relationship between the emotion regulation subscales and continuous measures of physical activity (i.e., Stanford 7-Day Recall moderate and vigorous physical activity; cardiorespitory endurance as measured by the perceived functional ability items). Neither moderate nor vigorous physical activity over the past week were related to any of the 11 measures of emotion regulation. However, cardiorespiratory endurance was significantly correlated with two subcategories of the CERQ: "Refocus on planning," $r = 0.42$, $p < 0.01$, and "putting into perspective," $r = 0.40$, $p < 0.01$. It was not significantly related to the other nine subscales of emotion regulation. Self-reported trait self-

control was only found to be significantly related to moderate, $r = 0.41$, $p = 0.01$, and vigorous, $r = 0.38$, $p = 0.01$, physical activity over the past week. Mean scores on the exercise self-regulation goals questionnaire were only significantly related to vigorous physical activity over the past week, $r = 0.31$, $p = 0.04$, and cardiorespiratory endurance, $r = 0.39$, $p = 0.01$. Mean scores on the exercise self-regulation plans questionnaire were only significantly related to vigorous physical activity over the past week, $r = 0.44$, $p < 0.01$, and cardiorespiratory endurance, $r = 0.44$, $p < 0.01$. This means that moderate activity may not have an effect on exercise self-regulation plans. It may also mean that physically being in shape may impact exercise self-regulation plans, more so than time spent exercising.

As an alternative way to examine how exercise behavior might be related to trait levels of emotion regulation, exercise self-regulation, and self-control, a final analysis compared individuals on a sports team (i.e., intercollegiate, intramural, club, or multiple types) to those not on a sports team. The only difference found was for rumination as measured by the CERQ. Those on a team reported lower levels of rumination ($M = 5.48$, $SD = 1.72$) than those who reported not being on a sports team ($M = 6.80$, $SD = 1.93$), $t(43) = -2.40$, $p = 0.02$ (see Figure 4). Thus, although being on a sports team was not related to several types of emotion regulation, trait self-control, or exercise-specific self-regulation, it was linked to levels of rumination as an emotion regulation strategy.

Discussion

The results of the experimental manipulation of exercise intensity did not support any of the hypotheses regarding its impact on emotion regulation. Specifically, the intensity of physical activity during the exercise task was not shown to create any significant differences in arousal or valence during trials that examined the emotion regulation strategies of distraction, reappraisal,

and suppression. It was clear that the exercise manipulation worked, as participants in the high-intensity condition perceived the task as being more strenuous, physically challenging, effortful, and felt more short of breath than those in the low-intensity condition. They also correctly reported their bpm assignment for their respective conditions. If the exercise manipulation had not worked, it would be possible that the failure to find differences may have been attributed to this, but it seems that this was not the case.

The picture task yielded three major findings that are crucial to an evaluation of the results of this thesis. First, it is clear that the IAPS pictures in the picture task also worked as they should. This is known because participants rated the neutral "VIEW" trials as significantly higher on valence and lower on arousal than any of the categories of negative pictures. If the pictures had not worked as they were supposed to, there would have been no difference between any of the conditions or the neutral images would have been rated more negatively and as more arousing than the negative images. Thus, the evidence suggests that the IAPS were accurately labeled and selected.

Second, there was no difference found between any of the four cues for negative images: watch, distract, reappraise, and suppress. This shows that although participants had to answer questions to ensure understanding of the task and clearly understood what was supposed to be done, participants did not employ the assigned emotion regulation strategies in the picture task. If participants had used the strategies, ratings on the command "Watch" would have been different than those trials on which participants received the "Distract," "Reappraise," or "Suppress" commands. For the "Watch" trials, participants were instructed not to do anything to regulate their emotions in response to the negative picture. Therefore, ratings of valence should have been lower than the three emotion regulation trials, and ratings of arousal should have been higher.

These results suggest that participants were either unable or unwilling to actually modify their emotional reactions in response to the prompts.

Third, the results of the picture task showed that there was no difference between the high- and low-intensity exercise conditions on any of the three emotion regulation strategy categories in terms of valence and arousal ratings. As described above, directions were thoroughly explained to all of the participants. To ensure they understood exactly what to do, individuals had to answer four understanding check questions before the picture task began, and only participants who answered at least two of these questions correctly were included in the study. Although participants reported an understanding about what each prompt meant, the data clearly shows that participants did not modify their emotional reactions in response to these prompts. Being able to answer questions about the task versus actually employing the strategy when a picture appears on the screen may be two very different behaviors. Individuals may have understood what to do, but struggled using the strategy in the experimental task. It is also possible that even though participants understood what to do, they may have become fatigued or bored and stopped employing the strategies at all. Another possibility is that there are no immediate effects of exercise on emotion regulation. However, what is more probable is that the picture task used may have not been able to detect these differences. If every aspect of the study stayed the same, but a different task was used to regulate emotions, it is possible that the hypotheses would have been supported. Also, emotion regulation is attributed to many factors; exercise is one of many that have been investigated. It is possible that other factors may have a more significant effect on emotion regulation than exercise, such as a person's upbringing or experiences. If it were possible for these factors to be held constant, it is possible that an effect could have been seen.

Although the main hypotheses were not supported, some other interesting outcomes were found. First, participants' reports of their Stage of Exercise Change were related to exercise self-regulation in the form of goals and plans. The statements that participants chose represented precontemplation, contemplation, preparation, action or maintenance (Marcus et al., 1992). This makes sense because people that currently exercise more are more likely to continue that into the future, and therefore have more goals and plans of doing so compared to people who exercise less. Second, cardiorespiratory endurance, as measured by the Perceived Functional Ability items, was found to be related to the categories of "Refocus on Planning" and "Putting into Perspective" on the CERQ. According to Garnefski and colleagues (2002), "Refocus on Planning" refers to thinking about what steps to take and how to handle the negative event and "Putting into Perspective" refers to downgrading the importance of an event. The perceived functional ability items measure how in shape an individual views himself or herself to be and is highly correlated with VO2 max (Eskes, Longman, Brown, McMorris, Langdon, Hogan & Poulin, 2010). The more highly functioning one perceives his or her fitness abilities, the greater VO2 max he or she will have. VO2 max is the maximum amount of oxygen the body can use during a specified period of exercise and depends on body weight, as well as lung strength (VO2 max, 2015). There is a large body of research on the relationship between VO2 max and cognition, and it has been found to be a predictor of cognitive performance, attention, and executive function (Eskes et al., 2010). If those with a higher perceived functional ability generally have better cognition, then those individuals will have an easier time putting things into perspective and refocusing on goals. This is also an important finding because it may suggest that emotion regulation may have more to do with being in shape than time spent exercising. No relationship was found between Stages of Exercise Change or the Stanford 7-Day

Recall and any form of emotion regulation. These questionnaires both dealt with time spent exercising. Because the only major finding was related to the Perceived Functional Ability scale, which addresses fitness rather than time spent exercising, it offers support for this possibility.

Finally, it was found that individuals that are on sports teams reported lower levels of rumination than those who are not on a sports team. Rumination is an emotion regulation strategy in which individuals focus on thoughts of negative information health (Nolen-Hoeksema, Wisco, & Lyubomirsky, 2008). Lower levels of rumination lead to less depression and better psychological health (Nolen-Hoeksema et al., 2008) as well as better physical health (Thomsen, Mehlsen, Olesen, Hokland, Viidik, Avlund, & Zachariae, 2004). One possible reason for the finding from this thesis is the fact that athletes are trained to deal effectively with negative events. For example, athletes must be able to get over a bad play or a loss in a timely fashion in order to move on to the next step. This may imply that an additional benefit of sports participation is the ability to deal effectively with negative events in different life domains.

In addition to these findings and the lack of support for the main hypotheses, there are several limitations to this thesis that should be noted. First, the small sample size was a definite limiting factor of the study, as only the data of 45 participants could be included. This was because although there were more individuals who participated in the study, some were excluded due to the fact that they either did not understand the directions or they failed attention checks. The low overall sample size used has the consequence of low power. Statistical power refers to the ability to find a statistically significant difference when one actually exists and when the null hypothesis is false (Power analysis, 2015). Thus, it is plausible that small effects (i.e., relationships between variables or differences between groups) were undetectable, given the limited sample size.

Another issue that occurred during the execution of this thesis was related to the accuracy of manipulation in the exercise portion of the experiment. For the purposes of ease and sanitation, a watch heart rate monitor was used rather than a strap monitor. Strap heart rate monitors go around the midsection of one's body, must be directly on the skin, and are generally more accurate. The exercise manipulation check did show that participants perceived the two conditions as being different. However, the accuracy of the bpm manipulation is up for question, in that participants may not have been able to exactly stay within the specified heart rate range. At the same time, participants did perceive their respective conditions to differ in terms of intensity. Thus, although there may have been some inaccuracy in the recording of participants' bpm during the cycling task, it is likely that the groups did perform at different intensity levels.

Perhaps the most major limitation of the study and reason that the hypotheses were not supported is that all emotion information was based on self-report. Participants rated their own levels of valence and arousal. In one sense, it would be impossible for anyone else to know exactly how an individual is feeling about an image. On the other hand, however, people could have very different standards of valence and arousal and because of the small sample size in particular, these differences could have affected the results. It is possible that there were a small number of people that rated levels of valence and arousal as unusually high or low and because there was not a large number of participants, this could shift the mean. This study was largely based off of Thiruchselvam et al. (2011) and in that study, the participants engaged in the same picture task but were assessed using an EEG as well, as another measure of arousal that is not prone to the same self-report biases. Another problem with self-report that could have been a factor in this study is social desirability. Participants are generally not going to want to report that they never work out or that they are awful at regulating their emotions, so they may not tell

the complete truth on questionnaires which could have possibly affected the cross-sectional results as well.

There is a body of research to support the current hypothesis that people that exercise more are better at regulating their emotions. Although the current study did not find this, this could have been for a variety of reasons, such as the tasks employed, the strategies selected, and/or individual differences that were not controlled. Exercise promotion is a widespread phenomenon in today's society. Not only is it widely known to improve physical health, but previous research has shown that it also works to improve psychological health, which the current study attempted to support. Emotions serve many important functions, including supporting goals and hedonic needs and facilitating the global personality system (Koole, 2009). If exercise could lead to improved emotion regulation abilities, then these functions that are crucial to our well-being could be more efficient than ever. The effect that exercise has on emotion regulation is certainly still an open question. One way that it could be studied in the future is using the same method that was used in the current study, but using a different emotion regulation task. For example, Mata et al. (2013) asked participants to watch a 2-minute sad film clip and rate their emotional response afterwards. Because the emotion regulation task was the only part of the current study that did not work as expected, this revised method could lead to results that previous research suggests. The effect that exercise has on emotion regulation is an important question in today's society and research on it should be continued in the future.

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Table 1

Correlation between Physical Activity Questionnaires and Ratings of Valence and Arousal during Regulation Task

	1	**2**	**3**	**4**	**5**
1. 7-Day Recall:Moderate Exercise	-	0.07	-0.121	0.034	0.033
2. 7-Day Recall:Vigorous Exercise	0.07	-	.536**	-0.149	-.110
3. Perceived Functional Ability	-0.121	.536**	-	-0.012	-0.039
4. Arousal: Distract	0.034	-0.149	-0.012	-	.894**
5. Arousal: Reappraise	0.033	-0.11	-0.039	.894**	-
6. Arousal: Suppress	0.105	-0.125	-0.065	.916**	.909**
7. Valence: Distract	-0.054	0.179	0.134	-.691**	-.580
8. Valence: Reappraise	-0.058	0.24	0.136	-.584**	-.510**
9. Valence: Suppress	-0.025	0.252	0.099	-.658	-.543

	6	**7**	**8**	**9**
1. 7-Day Recall:Moderate Exercise	0.105	-.054	-0.058	-0.025
2. 7-Day Recall:Vigorous Exercise	-.125	0.179	0.24	0.252
3. Perceived Functional Ability	-.065	0.134	0.136	0.099
4. Arousal: Distract	.916**	-.691**	-.584**	-.658**
5. Arousal: Reappraise	.909**	-.580**	-.510**	-.543**
6. Arousal: Suppress	-	-.601**	-.554**	-.658**
7. Valence: Distract	-.601	-	.824**	.814**
8. Valence: Reappraise	-.554**	.824**	-	.794**
9. Valence: Suppress	-.658**	.814**	.794**	-

**. Correlation is significant at the 0.01 level (2-tailed)

Table 2

Correlations between Physical Activity Questionnaires and Trait-Level Emotion Regulation based on the Emotion Regulation Questionnaire and the Cognitive Emotion Regulation Questionnaire

	1	2	3	4	5
1. 7-Day Recall:Moderate Exercise	-	0.07	-0.121	0.203	0.119
2. 7-Day Recall:Vigorous Exercise	0.07	-	.536**	0.036	0.238
3. Perceived Functional Ability	-0.121	.536**	-	0.2	-0.077
4. ERQ: Reappraisal	0.203	0.036	0.2	-	-0.258
5. ERQ: Suppression	0.119	0.238	-0.077	-0.258	-
6. CERQ: Acceptance	-.269	-0.125	0.2	0.036	-0.162
7. CERQ: Focus on Thought	-.090	-0.255	-0.085	-0.163	-0.166
8. CERQ: Positive Reappraisal	0.124	-0.149	0.193	.391**	-0.310
9. CERQ: Self-Blame	0.181	-0.055	-0.145	0.031	0.275
10. CERQ: Positive Refocusing	0.085	0.025	0.092	.496**	-0.233
11. CERQ: Catastrophizing	-0.17	-0.154	-0.245	-.459**	0.117
12. CERQ: Refocus on Planning	0.125	0.108	.418**	.399**	-0.331
13. CERQ: Putting into Perspective	-0.002	0.174	.406**	.315*	-0.366
14: Other Blame	-0.204	-0.175	0.087	-.148	-0.034
15: Brief Self-Control	.407**	.375*	0.146	.296*	0.111
16. Exercise Goals	0.211	.313*	.388**	0.215	-0.037
17. Exercise Plans	0.256	.438**	.441**	0.285	0.029

	6	7	8	9	10
1. 7-Day Recall:Moderate Exercise	-0.269	-0.09	0.124	0.181	0.085
2. 7-Day Recall:Vigorous Exercise	-0.125	-0.255	-0.149	-0.055	0.025
3. Perceived Functional Ability	0.200	-0.085	0.193	-0.145	0.092
4. ERQ: Reappraisal	0.036	-0.163	0.391	0.031	0.496
5. ERQ: Suppression	-0.162	-0.166	-0.310	0.275	-0.233
6. CERQ: Acceptance	-	0.213	0.423	0.245	0.283
7. CERQ: Focus on Thought	0.213	-	0.022	0.208	-0.018
8. CERQ: Positive Reappraisal	0.423	0.022	-	0.025	0.261
9. CERQ: Self-Blame	0.245	0.208	0.025	-	-0.263
10. CERQ: Positive Refocusing	0.283	-0.018	0.261	-0.263	-
11. CERQ: Catastrophizing	0.026	0.637	-0.321	0.047	-0.131
12. CERQ: Refocus on Planning	0.227	0.296	0.382	-0.124	0.367
13. CERQ: Putting into Perspective	0.448	-0.007	0.574	0.044	0.317
14: Other Blame	0.072	0.333	-0.016	-0.277	0.226
15: Brief Self-Control	-0.135	-0.386	0.253	-0.029	0.077
16. Exercise Goals	0.137	0.175	0.062	0.065	0.192
17. Exercise Plans	0.147	0.118	0.251	0.091	0.116

	11	12	13	14	15
1. 7-Day Recall:Moderate Exercise	-0.17	0.125	-0.002	-0.204	0.407
2. 7-Day Recall:Vigorous Exercise	-0.154	0.108	0.174	-0.175	0.375
3. Perceived Functional Ability	-0.245	0.418	0.406	0.087	0.146
4. ERQ: Reappraisal	-0.459	0.399	0.315	-0.148	0.296
5. ERQ: Suppression	0.117	-0.331	-0.366	-0.034	0.111
6. CERQ: Acceptance	0.026	0.227	0.448	0.072	-0.135
7. CERQ: Focus on Thought	0.637	0.296	-0.007	0.333	-0.386
8. CERQ: Positive Reappraisal	-0.321	0.382	0.574	-0.016	0.253
9. CERQ: Self-Blame	0.047	-0.124	0.044	-0.277	-0.029
10. CERQ: Positive Refocusing	-0.131	0.367	0.317	0.226	0.077
11. CERQ: Catastrophizing	-	-0.204	-0.341	0.472	-0.51
12. CERQ: Refocus on Planning	-0.204	-	0.638	0.18	-0.015
13. CERQ: Putting into Perspective	-0.341	0.638	-	-0.016	-0.19
14: Other Blame	0.472	0.18	-0.016	-	-0.339
15: Brief Self-Control	-0.51	-0.015	-0.019	-0.339	-
16. Exercise Goals	-0.034	0.414	0.201	0.153	0.297
17. Exercise Plans	-0.101	0.41	0.41	-0.115	0.45

	16	17
1. 7-Day Recall:Moderate Exercise	0.211	0.256
2. 7-Day Recall:Vigorous Exercise	0.313	0.438
3. Perceived Functional Ability	0.388	0.441
4. ERQ: Reappraisal	0.215	0.285
5. ERQ: Suppression	-0.037	0.029
6. CERQ: Acceptance	0.137	0.147
7. CERQ: Focus on Thought	0.175	0.118
8. CERQ: Positive Reappraisal	0.062	0.251
9. CERQ: Self-Blame	0.065	0.091
10. CERQ: Positive Refocusing	0.192	0.116
11. CERQ: Catastrophizing	-0.034	-0.101
12. CERQ: Refocus on Planning	0.414	0.41
13. CERQ: Putting into Perspective	0.201	0.293
14: Other Blame	0.153	-0.115
15: Brief Self-Control	0.297	0.45
16. Exercise Goals	-	0.684
17. Exercise Plans	0.684	-

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

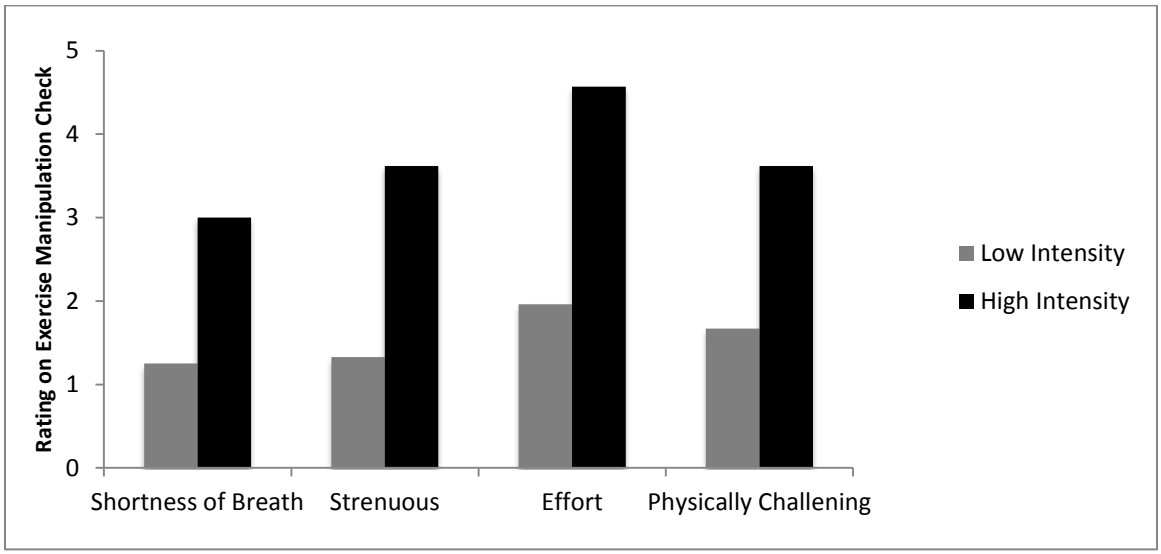

Figure 1. Low-intensity exercise condition (70-90 bpm) and high-intensity condition (140-160 bpm) responses on the exercise manipulation check.

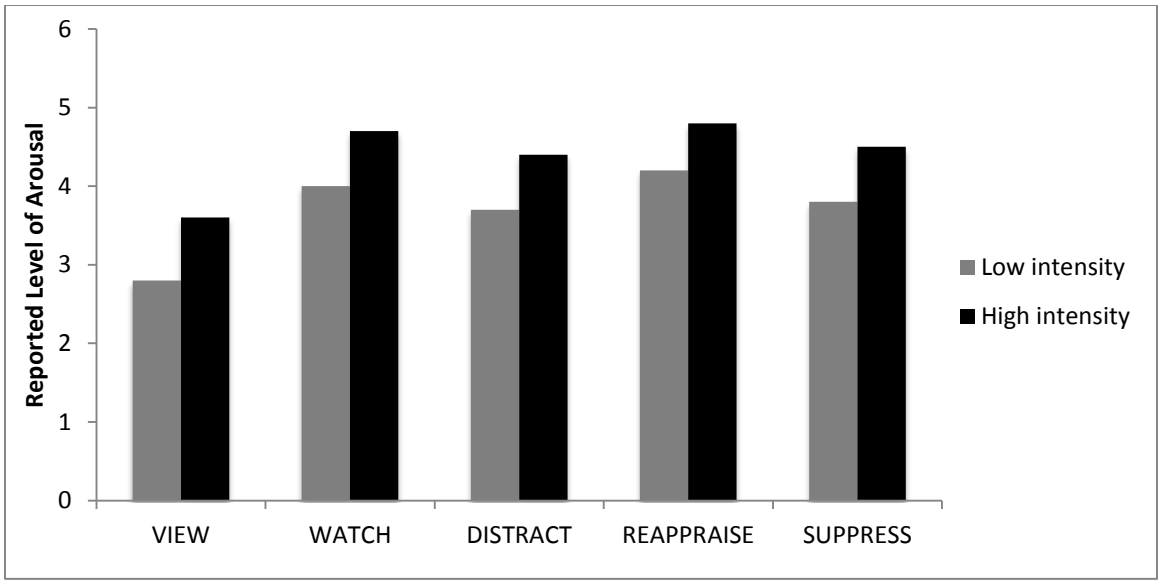

Figure 2. Ratings of arousal by the low-intensity and high-intensity conditions on the emotion regulation task.

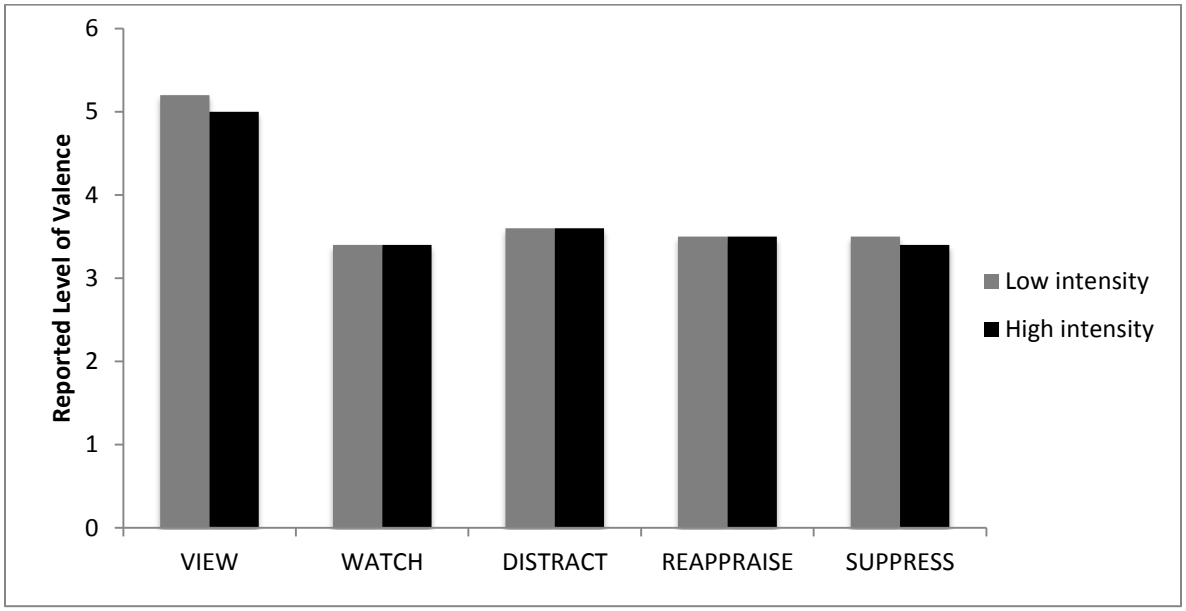

Figure 3. Ratings of valence by the low-intensity and high-intensity conditions on the emotion regulation task.

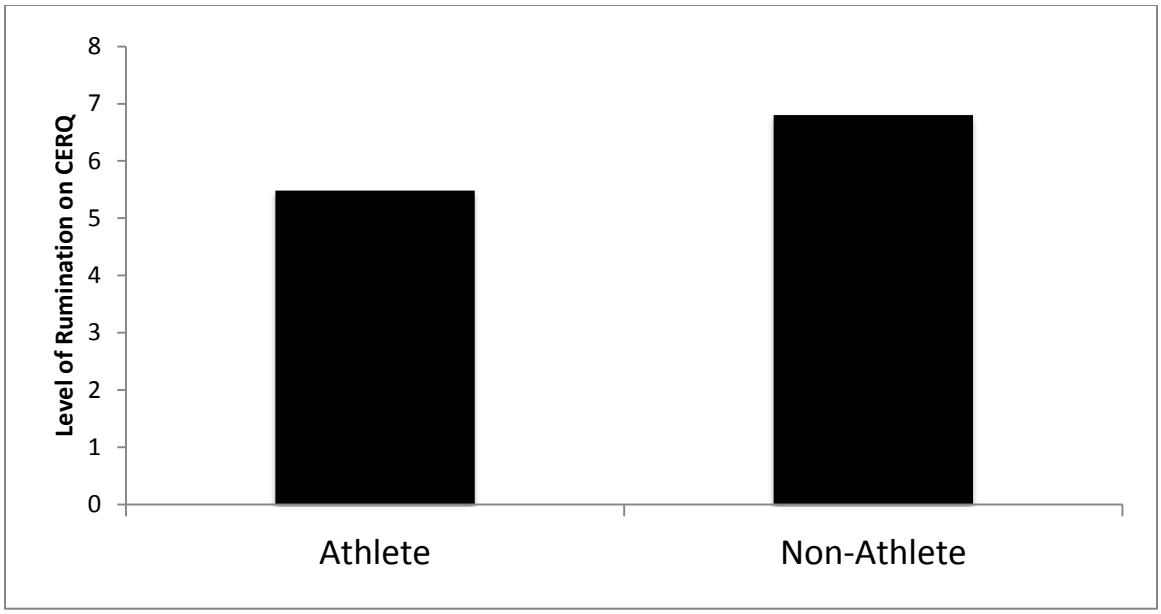

Figure 4. Athletes versus non-athletes on levels of rumination.

Appendix A

<u>Exercise Manipulation Questionnaire</u>

1. **What heart rate were you assigned to maintain during the main portion of the physical activity? ______**
2. **What heart rate did you personally try to maintain during the main portion of the physical activity? ______**
3. **What was your average heart rate during the main portion of the physical activity? ______**
4. **How well were you able to maintain your assigned heart rate?**

X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X

Very Poorly — Very Well

5. **When you checked the heart rate monitor, were you generally cycling at the assigned beats per minute?**

X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X

No — Yes

6. **How easy was it to track your heart rate using the monitor?**

X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X

Very Easy — Very Hard

7. **Did you find it difficult to stay within the specific, assigned heart rate range?**

X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X

Not At all — Very Much

8. **How hard did you try to maintain your assigned heart rate during the cycling task?**

X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X

Very Little — Very Much

9. **To what extent, did you find yourself short of breath during the majority of this task?**

X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X

Very Little — Very Much

10. **How strenuous did you find the level of physical activity to be?**

X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X

Very Easy — Very Hard

11. **How much physical effort did you exert on the cycling task?**

X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X

Very Little — Very Much

12. **How physically challenging did you find the cycling task to be?**

X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X

Not At all — Very Much

13. To what extent, were you able to keep your attention centered on exercising?
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
Not At all — Very Much

14. How much did you enjoy working on the cycling task?
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
Very Little — Very Much

15. How unpleasant was the cycling task?
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
Not At all — Very Much

16. How much did this cycling make you feel energized?
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
Very Little — Very Much

17. How much did this cycling make you feel tired?
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
Very Little — Very Much

18. How stressful did you find this cycling task?
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
Not At all — Very Much

19. How much did this cycling task make your feel anxious?
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
Not At all — Very Much

20. How much did this cycling task make you feel uncomfortable?
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
Very Little — Very Much

21. How much did you think about yourself while working on the cycling task?
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
Very Little — Very Much

22. How much did this cycling task make you feel self-conscious?
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
Very Little — Very Much

23. How much did you feel the cycling task was important to the experiment?
X X X X X X X X X X X X X X X X X X X X X X X X X X X X X X
Not At all — Very Much

Appendix B

Understanding Check (before task begins):

Open-ended questions (presented in counter-balanced order):

- Explain what you should do when you should do when you see the command "View." (If you do not know the answer, please ring for your experimenter to repeat the directions).
    - *After-writing response:* "View = Simply attend to the image and do not be concerned with what thoughts are coming to mind. Allow yourself to continue to feel whatever it was you were feeling previously about the picture, as you naturally would."
        - Was your response correct? Yes No
        - Do you understand the "View" command? Yes No
        - How confident are you that you will be able to perform the "View" strategy when the images are presented? 1 (Not at all confident) to 5 (Very confident)
- Explain what you should do when you should do when you see the command "Watch." (If you do not know the answer, please ring for your experimenter to repeat the directions).
    - *After-writing response:* "Watch = Simply attend to the image and do not be concerned with what thoughts are coming to mind. Allow yourself to continue to feel whatever it was you were feeling previously about the picture, as you naturally would."
        - Was your response correct? Yes No
        - Do you understand the "Watch" command? Yes No
        - How confident are you that you will be able to perform the "Watch" strategy when the images are presented? 1 (Not at all confident) to 5 (Very confident)
- Explain what you should do when you should do when you see the command "Distract." (If you do not know the answer, please ring for your experimenter to repeat the directions).
    - *After-writing response:* "Distract = Try to feel neutral in response to the image by generating thoughts unrelated to the image on the screen. You may think of anything you want in order to feel neutral about the image."
        - Was your response correct? Yes No
        - Do you understand the "Distract" command? Yes No
        - How confident are you that you will be able to perform the "Distract" strategy when the images are presented? 1 (Not at all confident) to 5 (Very confident)
- Explain what you should do when you should do when you see the command "Reappraise." (If you do not know the answer, please ring for your experimenter to repeat the directions).
    - *After-writing response:* "Reappraise = try to feel neutral in response by altering your understanding of the image. For example, imagine that the picture may improve over time or the scene depicted might be happening for a good reason or might be fake."

        - Was your response correct? Yes No
        - Do you understand the "Reappraise" command? Yes No
        - How confident are you that you will be able to perform the "Reappraise" strategy when the images are presented? 1 (Not at all confident) to 5 (Very confident)
- Explain what you should do when you should do when you see the command "Suppress." (If you do not know the answer, please ring for your experimenter to repeat the directions).
    - *After-writing response:* "Suppress = Simply try to minimize your emotional reaction to the image, and have less intense of a response."
        - Was your response correct? Yes No
        - Do you understand the "Suppress" command? Yes No
        - How confident are you that you will be able to perform the "Suppress" strategy when the images are presented? 1 (Not at all confident) to 5 (Very confident)

Directions: After you are show each picture and perform the prompted strategy while it is presented, you will then be asked about your feelings towards the image on two dimensions: Valence and Arousal. Valence is how positive and attractive or negative and aversive a stimulus makes you feel, whereas arousal is how intensely you feel a particular emotion. During the Picture Task, it is important that you respond honestly and accurately about how each picture makes you feel, regardless of the viewing strategy that you were asked to employ. You will use a scale with figures that portray valence, ranging from very negative to very positive feelings, and arousal, ranging from low-intensity to high-intensity.

Click on the best answer: *(If participant selects wrong option, definition of valence will be shown again before he/she can continue).*

1. If a picture made you feel very positively, you will select a low valence rating.
2. If a picture made you feel very positively, you will select a high valence rating
3. If a picture made you feel neither positive nor negative, you will select a low valence rating.
4. If a picture made you feel very negatively, you will select a high valence rating

Click on the best answer: *(If participant selects wrong option, definition of valence will be shown again before he/she can continue).*

1. If you felt a picture was really attractive, you will select a low valence rating.
2. If you felt a picture was neither attractive nor aversive, you will select a low valence rating.
3. If you felt a picture was really aversive, you will select a low valence rating.
4. If you felt a picture was really aversive, you will select a high valence rating.

Click on the best answer: *(If participant selects wrong option, definition of valence will be shown again before he/she can continue).*

1. If you feel intense negativity OR positivity towards a picture, you will select a low arousal rating.

2. If you feel intense negativity OR positivity towards a picture, you will select a high arousal rating.
3. If you feel slightly negative towards a picture, you will select a high arousal rating.
4. If you feel slightly positive towards a picture, you will select a high arousal rating.

Click on the best answer: *(If participant selects wrong option, definition of valence will be shown again before he/she can continue).*

1. If you feel strongly negative towards a picture, you will select a low arousal rating.
2. If you feel mildly negative towards a picture, you will select a high arousal rating.
3. If you feel mildly positive towards a picture, you will select a high arousal rating.
4. If you feel mildly positive towards a picture, you will select a low arousal rating.

Appendix C
Emotion Regulation Task Questionnaire

1) Rate your accuracy in following the directions given the prompts

   Very Low XXXXXXX Very High

2) How much effort did you exert on the task?

   Very Little XXXXXXX Very Much

3) Rate your confidence in your ability to follow the prompts: View, Watch, Distract, Reappraise, and Suppress.

   Very Low XXXXXXX Very High

4) How much did you enjoy working on the task?

   Very Little XXXXXXX Very Much

5) How mentally fatigued do you feel right now?

   Very Little XXXXXXX Very Much

6) How hard did you try on the task?

   Very Little XXXXXXX Very Much

7) How challenging did you find the task to be?

   Very Little XXXXXXX Very Much

8) How interested were you in the task?

   Very Little XXXXXXX Very Much

9) How anxious did the task make you feel?

   Very Little XXXXXXX Very Much

10) How unpleasant was the task?

    Very Little XXXXXXX Very Much

11) How much did you think about yourself while working on the task?

Very Little XXXXXXX Very Much

12) How well were you able to follow the directional prompts when seeing each picture?

Very Little XXXXXXX Very Much

13) To what extent, did you naturally react to the images presented?

Very Little XXXXXXX Very Much

14) How confusing was the task?

Very Little XXXXXXX Very Much

15) How stressful did you find this task?

Very Little XXXXXXX Very Much

16) How much did you like the task?

Very Little XXXXXXX Very Much

17) How aroused did the task make you feel?

Very Little XXXXXXX Very Much

18) How much did you feel the task was important?

Very Little XXXXXXX Very Much

19) How much did you have to control yourself and your reactions during the task?

Very Little XXXXXXX Very Much

20) Were you able to alter your autonomic reaction to the images when prompted to do so?

Very Little XXXXXXX Very Much

21) How physically tired do you feel right now?

Very Little XXXXXXX Very Much

22) How much effort did you exert on the task?

Very Little XXXXXXX Very Much

23) How difficult was the task?

Not Very XXXXXXX Very Much

24) To what extent, were you able to keep your attention centered on the task?

Not at all XXXXXXX Very Much

25) How disgusting did you find the task to be?

Not at all XXXXXXX Very Much

26) If you had any issues, problems, or concerns about this task, please list them here. If you had none, please simply type “none”.
_____

27) In what way could your participation in the exercise portion of this study have impacted the way in which you reacted to the picture task?
_____

Appendix D

Demographic Questionnaire

1) What is your gender?
(1) Male
(2) Female

2) What is your age? _____

3) What is your height? ___feet ___inches

4) What is your weight? _____ pounds

5) What is your ideal weight? _____ pounds

6) What is the most that you have ever weighed? _____ pounds

7) Are you on a sports team?
(1) Yes
(2) No

8) If yes, please circle which type of team you are a part of:
(1) Intercollegiate
(2) Intramural
(3) Club
(4) Recreational

9) What ethnicity do you consider yourself to be? Select one or more of the following.
(1) American Indian or Alaskan Native
(2) Asian
(3) Black or African-American
(4) Hispanic or Latino
(5) Native Hawaiian or other Pacific Islander
(6) White
(7) Other (Please specify) _____
(8) I prefer not to answer this question

10) How would you describe your religious background?
(1) Catholic
(2) Islamic
(3) Jewish
(4) Protestant (e.g., Baptist, Methodist, Lutheran)
(5) None
(6) Other (Please specify) _____

11) Please indicate how committed you are to your religious beliefs:
(1) Devout (Strong)
(2) Moderate
(3) Inactive

12) People take surveys for a lot of reasons. Were you completely honest and serious in responding to this survey? Or were you joking around or giving less-than-honest responses?
(1) I answered the survey seriously and honestly.
(2) I provided joking or less-than-honest responses to the survey.